Fishery Data Series No. 16-39

Unalakleet River Chinook Salmon Escapement Monitoring and Assessment, 2013–2014

Annual Report for Project FIS 14-101

USFWS Office of Subsistence Management

Fisheries Resource Monitoring Program

by

Scott M. Kent

Jenefer Bell

and

Larry Neff

September 2016

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat or long
monetary symbols (U.S.)	\$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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by
Scott M. Kent, Jenefer Bell, and Larry Neff
Alaska Department of Fish and Game, Division of Commercial Fisheries, Nome

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1565

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Scott Kent, Jenefer Bell, and Larry Neff
Alaska Department of Fish and Game, Division of Commercial Fisheries,
Box 1148, Nome, AK, 99762, USA

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TABLE OF CONTENTS

Page

LIST OF TABLES ... ii

LIST OF FIGURES ... ii

LIST OF APPENDICES ... ii

ABSTRACT ... 1

INTRODUCTION ... 1

OBJECTIVES ... 2

METHODS ... 2

Study Area ... 2

Resistance Board Weir Design, Installation, and Operation ... 3

Data Collection ... 4

Weather and Stream Observations ... 5

Interpolating Unmonitored Weir Passage ... 5

Age, Sex, and Length Data Collection ... 6

- Chinook Salmon Capture Methods ... 6
- Distribution and Sample Sizes ... 6
- Sample Collection Procedures ... 7

RESULTS ... 7

Weir Operations ... 7

- 2013 ... 7
- 2014 ... 7

Chinook Salmon Run Timing and Escapement ... 9

Age, Sex, and Length Composition ... 9

DISCUSSION ... 9

ACKNOWLEDGEMENTS ... 10

REFERENCES CITED ... 11

APPENDIX ... 13

LIST OF TABLES

Table **Page**

1 Chinook salmon ASL sampling intervals and daily collection goals at Unalakleet River weir, 2014, Norton Sound. 6
2 Chinook salmon age, sex, and mean length (METF in mm), 2014, Unalakleet River weir, Norton Sound....... 10

LIST OF FIGURES

Figure **Page**

1 Commercial salmon fishing subdistricts and major salmon producing watersheds in the Norton Sound District....... 2
2 Locations of salmon stock assessment projects within the Unalakleet River drainage, Norton Sound....... 3
3 Example of Unalakleet River weir boat gate panel with UHMW pipe sections to safeguard PVC weir pickets against propeller strikes....... 5
4 Daily Chinook salmon passage and daily relative stream depth (cm), 2013, Unalakleet River weir, Norton Sound. 8
5 Daily Chinook salmon passage and daily relative river depth (cm), 2014, Unalakleet River weir, Norton Sound. 8

LIST OF APPENDICES

Appendix **Page**

A1 Daily and cumulative Chinook salmon passage, 2013–2014, Unalakleet River weir, Norton Sound....... 14
A2 Relative stream stage depth (cm) as indicated by stream gauge measurements, 2013–2014, Unalakleet River weir, Norton Sound. 16

ABSTRACT

Declining run sizes and ensuing state and federal restrictions and closures to Unalakleet River Chinook salmon *Oncorhynchus tshawytscha* fisheries highlighted the need to obtain more complete estimates of spawning escapement. In response, multiple agencies and entities began the Unalakleet River weir project in 2010 funded by United States Fish and Wildlife Service's Office of Subsistence Management to obtain estimates of the mainstem Chinook salmon escapement and its age, sex, and length composition. An estimated 667 and 1,126 Chinook salmon were enumerated during the 2013 and 2014 seasons. The central 50% of the Chinook salmon run was enumerated 7 July–18 July in 2013 and could not be determined in 2014 because Chinook salmon passage was not fully evaluated. In 2013, there were 3 days of partial counts. Interpolation of missed counts could not be completed in 2014 because of incomplete information about the exact duration and extent of unmonitored periods. Age composition could not be determined from the 2013 escapement samples because the minimum sampling goal was not achieved; sex composition was 52% female. In 2014, age-1.3 Chinook salmon comprised the majority (68%) of the escapement samples.

Key words: Chinook salmon *Oncorhynchus tshawytscha*, resistance board weir, North River, Unalakleet River

INTRODUCTION

Unalakleet River Pacific salmon (*Oncorhynchus* spp.) stocks contribute heavily to Norton Sound Subdistricts 5 (Shaktoolik) and 6 (Unalakleet; Figure 1) subsistence and commercial salmon fisheries (Menard et al. 2012). Although most salmon stocks to the Unalakleet River are considered healthy, Chinook salmon *O. tshawytscha* runs to the Unalakleet River drainage have been chronically depressed since the late 1990s.

The Alaska Board of Fisheries (BOF) designated Unalakleet River Chinook salmon as a stock of yield concern in 2004 (Kent and Bergstrom 2012). A "yield concern" is a concern arising from a chronic inability, despite the use of specific management measures, to maintain expected yields, or harvestable surpluses, above a stock's escapement needs. As a result of this designation, the Alaska Department of Fish and Game (ADF&G) has implemented a restrictive management plan in an effort to increase escapements and restore Unalakleet River Chinook salmon runs to historic levels of abundance.

Until recently, ADF&G has managed Unalakleet River Chinook salmon based primarily on inseason subsistence catch reports and counts of Chinook salmon observed at the North River tributary counting tower. Radiotelemetry studies revealed that North River accounts for 34–55% of the overall drainagewide Chinook salmon escapement (Wuttig 1999; Joy and Reed 2014). Lower river test fishery set gillnet catches of Chinook salmon and spawning ground aerial surveys are also used but are considered ancillary assessment tools. Further, collection of reliable Chinook salmon age, sex, and length (ASL) data from these existing projects has been problematic due to funding limitations, small and poorly distributed annual sample sizes, and mesh-size selectivity bias (Kent 2010).

Beginning in 2010, a resistance board or "floating" weir was operated by ADF&G, Native Village of Unalakleet (NVU), United States Bureau of Land Management (BLM), and Norton Sound Economic Development Corporation (NSEDC) on the mainstem of the Unalakleet River. Resistance board weirs are more effective than traditional fixed picket weirs at withstanding flood conditions, require less maintenance, and ultimately result in shorter periods of unmonitored fish passage (Stewart et al. 2009, 2010). Therefore, escapement counts from resistance board weirs are considered more complete. Additionally, weir traps may provide the least biased method of fish capture to obtain ASL data from live salmon.

This report presents the findings from the 2013 and 2014 seasons at the Unalakleet River floating weir project. Chinook salmon escapement, run timing, and ASL composition were estimated and compared between each season. The project is funded by United States Fish and Wildlife Service Office of Subsistence Management (USFWS OSM) to provide 2 priority information needs: 1) reliable estimates of Chinook salmon escapement, and 2) unbiased ASL composition from the spawning escapement. Escapement, run timing, and ASL data on other salmon species monitored with the Unalakleet weir are provided by year in the report series *Salmon escapements to the Norton Sound-Port Clarence Area* (Leon et al. 2016).

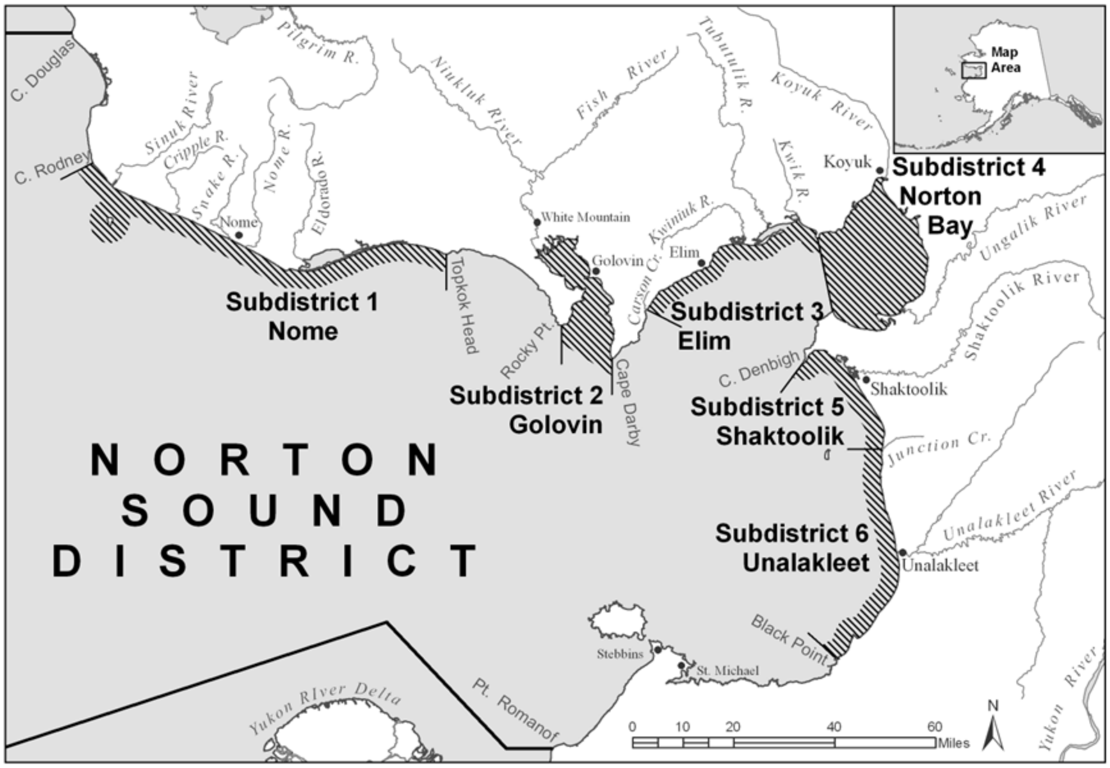

Figure 1.–Commercial salmon fishing subdistricts and major salmon producing watersheds in the Norton Sound District.

OBJECTIVES

Objectives for the Unalakleet River weir project were as follows:

1. Estimate daily and total Chinook salmon escapement during the target operational period.
2. Describe timing of Chinook salmon migration within the Unalakleet River mainstem.
3. Estimate ASL composition of the Unalakleet River Chinook salmon spawning escapement.

METHODS

STUDY AREA

The Unalakleet River and its 6 major tributaries have a drainage area of 2,815 square km, extending from the Nulato Hills. The river runs for approximately 210 km before emptying into the Bering Sea at the village of Unalakleet. The upper 81 river miles (130 rkm) of the mainstem of the Unalakleet River have been designated a National Wild River. Riparian vegetation throughout much of the drainage includes various assemblages of sedge grasses, muskeg bog flats, willow *Salix* spp., alder *Alnus* spp., western cottonwood *Populus fremontii*, black spruce *Picea mariana*, and white birch *Betula papyrifera*. Shale, clay, and loose soils characterize the majority of bank substrate of the Unalakleet River mainstem and its tributaries. In addition to Pacific salmon, the Unalakleet River supports resident populations of arctic grayling *Thymallus arcticus*, whitefish (*Coregonus* and *Prosopium* spp.), Dolly Varden char *Salvelinus malma*, and burbot *Lota lota*.

In 2001, ADF&G personnel identified a suitable resistance board weir site located approximately 22 kilometers upstream on the mainstem of the Unalakleet River (63°53.32′N, 160°29.41′W; Figure 2; Menard 2001; Todd 2003). This site was selected because of its favorable physical characteristics, including channel width (91 m), water depth (0.9–1.2 m), optimal stream velocity (0.9–1.2 m/s), and even bottom profile with gravel and small cobble bottom substrates to provide for stable anchoring of the weir. Additionally, radiotelemetry data have shown this site to be located well downstream of the entire mainstem Chinook salmon spawning distribution (Wuttig 1999; Joy and Reed 2014).

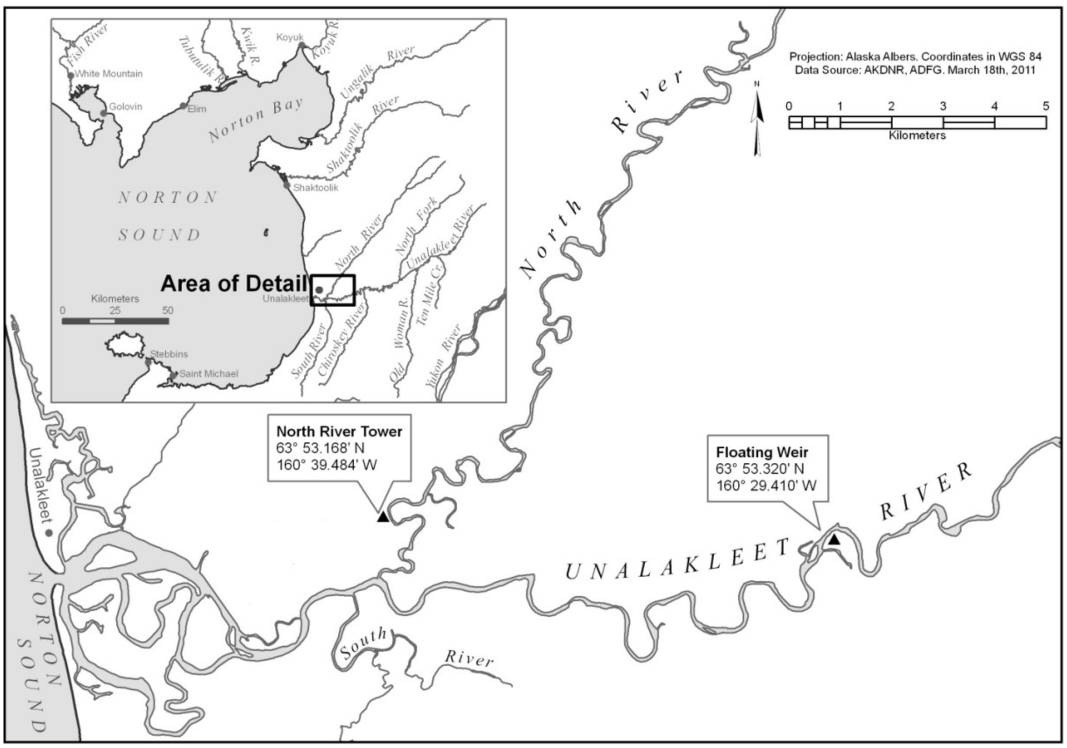

Figure 2.–Locations of salmon stock assessment projects within the Unalakleet River drainage, Norton Sound.

RESISTANCE BOARD WEIR DESIGN, INSTALLATION, AND OPERATION

Weir design and materials followed those described by Tobin (1994) with modifications outlined by Stewart (2002). Picket spacing was 3.2 cm, which imparted flexibility to the panels and allowed a complete census of all but the smallest returning salmon.

High water levels have hampered installation in 4 of the 5 years of operation, particularly in the thalweg of the channel. Following methods outlined by Stewart (2003), a tethering cable system upstream of the substrate rail was used to guide weir panels into position on the rail in deep sections of the river. Divers would use a knotted rope with a carabineer attached to the substrate rail to hold them in position in the deepest swiftest part of the river during installation.

For the first 4 years of the project, a single enclosed passage chute and live trap were installed upstream of the weir to serve as a platform for enumeration and ASL sampling of migrating salmon. However, to further reduce unmonitored periods during high water events, a second passage chute/live trap assembly was added during the 2014 season. This second chute/trap assembly was situated near shore to provide continued enumeration and ASL sampling during periods of high murky water that prohibited enumeration and sampling near the thalweg. Live traps were constructed from aluminum angle and channel stock and measured 1.5 m wide x 2.4 m long x 1.5 m deep. The trap floor was made of sandbags. A collapsible hinged entrance and removable 16 inch wide exit gate were also installed on the trap. During periods of high water and/ or diminished clarity, an angled insert covered with high visibility flash panel material was deployed into the exit door slot. This forced the salmon to the upper portion of the water column facilitating speciation and enumeration. To expedite passage of high numbers of pink salmon during the 2014 season, a nearshore panel picket would be pulled and one entire panel would be opened temporarily. A piece of flash panel material placed on the upstream side of the opened panel would help with speciation and enumeration.

Several systems for a boat passage/gate were utilized during the 2013 and 2014 seasons. Initially 4-inch drilled and split high-density polyethylene (HDPE) pipe was used on the boat pass to protect the polyvinyl chloride (PVC) panel pickets from damage from boat/prop strikes. This worked to some degree, but some of the larger prop boats still inflicted substantial damage to the PVC pickets on boat gate panels, which required recurring repair efforts.

In 2013 a covering of one-quarter-inch ultra-high-molecular-weight polyethylene (UHMW) plastic was added to the boat pass panels. Although this worked exceptionally well at protecting the panels from any boat damage, the increased associated drag caused the panels to be pushed several inches down in the water column during high water events. This design may have allowed salmon to pass without being enumerated and also made the boat pass panels extremely difficult to remove at the conclusion of the season.

In 2014 bisected 8 inch HDPE drain pipe was used, which seemed to have a good balance of boat strike and salmon containment protection (Figure 3). Large traffic cones topped with flashing net lights were affixed on either side of the boat pass to facilitate boat passage during low light periods.

For both the 2013 and 2014 seasons, the desired target operational period was mid-June to late August. This was to ensure that late Chinook salmon runs, like the 2010–2012 runs, were fully enumerated at the weir.

DATA COLLECTION

The weir was closed to fish passage except during onsite counting periods. Hourly or bi-hourly counts were conducted contingent upon fish movement behind the weir. Counting schedules were adjusted for changes in diurnal migratory patterns or operational constraints such as less favorable viewing conditions caused by high water levels. Flood lamps were used at night to aid in salmon identification. Salmon migrating upstream were identified by species and recorded on multiple tally counters as needed or until fish passage diminished.

Counts were recorded in write-in-the-rain notebooks before being transferred to hourly count forms. Total and cumulative daily counts were calculated and transferred to radio log forms to relay inseason estimates to fishery managers in the Nome Area office.

Figure 3.–Example of Unalakleet River weir boat gate panel with UHMW pipe sections to safeguard PVC weir pickets against propeller strikes.

WEATHER AND STREAM OBSERVATIONS

Stream and ambient air temperature (°C), relative water levels, and atmospheric observations (e.g., percent cloud cover, wind speed and direction) were measured twice daily. Additionally, a HOBO Pro v2 data logger (Onset Computer Corporation) was secured several inches off the bottom just upstream of the weir.[1] Weather, temperature, and hydrological observations were recorded in write-in-the-rain data forms and entered into Microsoft Excel spreadsheets.

INTERPOLATING UNMONITORED WEIR PASSAGE

Missing daily counts were interpolated using the moving average method described in Perry-Plake and Antonovich (2009). Partial-count days were considered days of minimum passage and therefore were not used to interpolate missed passage for days when the weir was not operational. When counts for consecutive days (k) were missed, the moving average estimate for the missing day (i) was calculated as:

$$\hat{N}_i = \frac{\sum_{j=i-k}^{i+k} I(\textit{counting was successfully conducted on day } j)\hat{N}_j}{\sum_{j=i-k}^{i+k} I(\textit{counting was successfully conducted on day } j)},$$

[1] Product names used in this report are included for scientific completeness but do not constitute a product endorsement.

where $I(\cdot) = \begin{cases} 1 & \text{when the condition is true} \\ 0 & \text{otherwise} \end{cases}$ is an indicator function.

AGE, SEX, AND LENGTH DATA COLLECTION

Chinook Salmon Capture Methods

An active sampling approach was implemented at the Unalakleet River weir to increase effectiveness of sampling Chinook salmon. Active sampling consists of capturing and sampling salmon individually or in small numbers while actively passing and counting all salmon (Linderman et al. 2002). At the start of the project in 2010, one crew member would count fish at the upstream end of the trap and a second crew member sat at the back of the trap. When Chinook salmon were observed entering the trap at the rear gate, crew members simultaneously closed the front and rear gates to trap fish. Limited success capturing Chinook salmon occurred using this method and in several instances Chinook salmon were enumerated immediately after the person sitting at the rear of the trap left the scene. Beginning in 2011, the enclosed bulkhead of the fish passage chute was connected to the live trap to obscure personnel positioned near the rear trap gate from the view of migrating Chinook salmon. Consequently, Chinook salmon entered the trap less hesitantly and at a much slower speed during the 2011–2014 seasons, which ultimately led to considerably improved capture of Chinook salmon.

Distribution and Sample Sizes

Minimum ASL sample sizes were determined following Bromaghin (1993) to achieve 95% confidence intervals of age-sex composition to be no wider than ±10% (α = 0.05 and d = 0.10), assuming 10 age-sex categories (n = 190). To ensure adequate temporal distribution, ASL samples were collected during the 2013 and 2014 seasons following a daily collection schedule in proportion to average historical escapement by day (Table 1). When necessary, sampling distributions and schedules were adjusted inseason to address differences between expected and observed run abundance and timing.

Table 1.–Chinook salmon ASL sampling intervals and daily collection goals at Unalakleet River weir, 2014, Norton Sound.

	Passage date	Expected sampling dates	Expected sample size	Samples/ day
First quarter point	29 Jun	June 17–29	57	4
Midpoint	6 Jul	June 30–July 6	58	8
Third quarter point	13 Jul	July 7–13	58	8
95% cumulative passage	20 Jul	July 14–20	57	8
Season total			230	

Sample Collection Procedures

Three scales were collected from each Chinook salmon for age determination. Sex was determined by visually examining external characteristics (such as body symmetry, kype development, and presence of an ovipositor) and length was measured to the nearest 1 mm from mid eye to tail fork (METF). Scales were removed from the left side of the fish in an area 2–3 scale rows above the lateral line crossed by a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (INPFC 1963). Scales were cleansed of slime and debris, mounted on gummed cards, and impressions were later made in cellulose acetate cards for age determination following methods described by Clutter and Whitesel (1956). Impressions were read with a microfiche reader and ages were determined from reading annuli as described by Mosher (1969). European notation was used to report ages in which the first digit refers to the freshwater age, not including the year spent in the gravel, and the second digit refers to the ocean age (Koo 1962).

RESULTS

WEIR OPERATIONS

2013

Favorably low water levels at the beginning of the 2013 season facilitated a complete installation of the weir and fish trap in 3 days. Counting operations commenced on 19 June and concluded on 22 August when the weir was disassembled for the season. Water levels at the weir rose nearly 9 inches (23 cm) on 2 July and an additional 20 inches (51 cm) by 5 July (Figure 4; Appendix A2). During 5–6 July and 9–10 July, the weir was completely submerged for portions of the day and salmon passed unmonitored; estimates of salmon passage for those dates should be considered minimum daily counts (Figure 4). Other than those breaches, the structural integrity of the resistance board weir was maintained and it functioned properly, providing accurate Chinook salmon counts for the remainder of the 2013 season.

2014

Weir installation was slated to begin on 13 June and be completed between 16 June and 18 June. However, an unanticipated substrate rail repair coupled with above average mid-June water levels delayed the installation by 10–12 days. As a result, the weir did not become operational until 28 June. It is probable that a significant number of Chinook salmon passage occurred prior to 28 June as a result of the early salmon run and delayed installation. On 17 June, crewmembers observed approximately 30 large salmon milling in a local fishing spot about 5 kilometers upstream of the weir site. On 14 July salmon passage for all species dropped off significantly, corresponding to the onset of a high water event; water levels eventually peaked at 43 inches (109 cm) on 20 July (Figure 5). The weir was fully breached from high water and doors of the traps were opened to further facilitate passage of salmon from 20 July to 26 July (Figure 5; Appendix A2).

On 1 August, crewmembers observed large numbers of salmon escaping under the weir substrate rail through a hole created by scouring. Once the breach was repaired, salmon passage increased. On 12 August, the weir was inspected and the boat pass and approximately one fifth of the weir was partially submerged due to rocks and debris embedded between the pickets. Upon removal of this debris, the boat pass and adjacent submerged sections of weir re-elevated back to normal operational positions until counting operations concluded on 26 August.

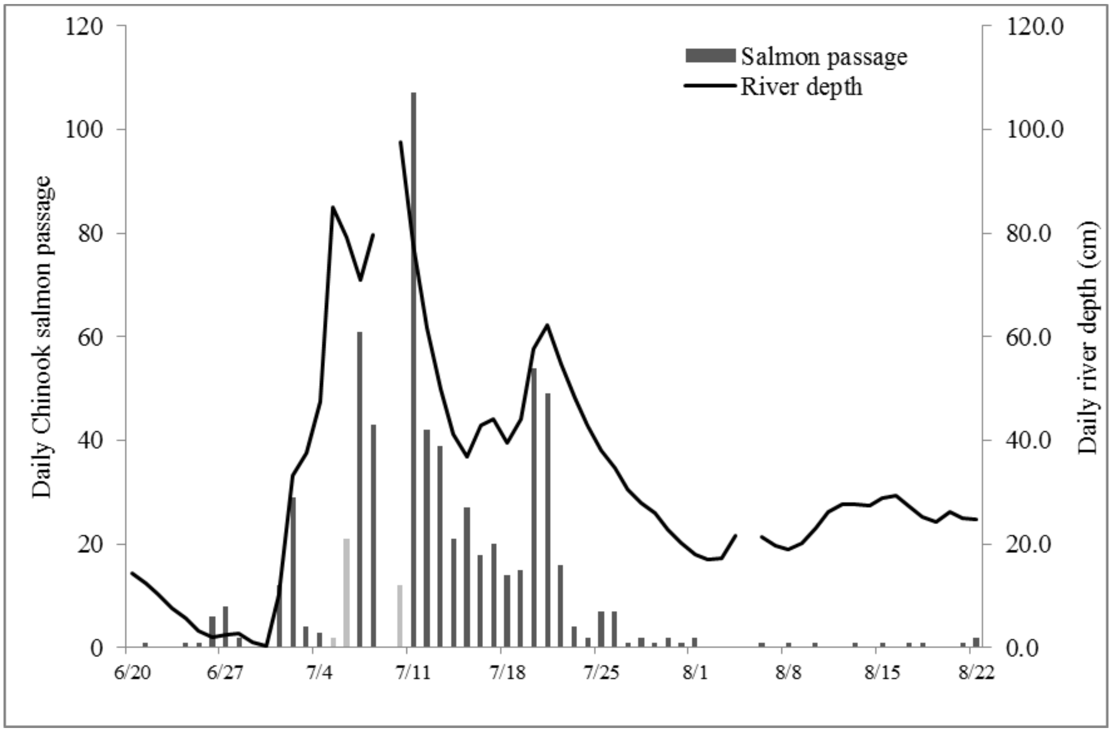

Figure 4.–Daily Chinook salmon passage and daily relative stream depth (cm), 2013, Unalakleet River weir, Norton Sound.

Note: Light gray bars signify partial day counts. River depth was not collected on 9–10 July and 5 August.

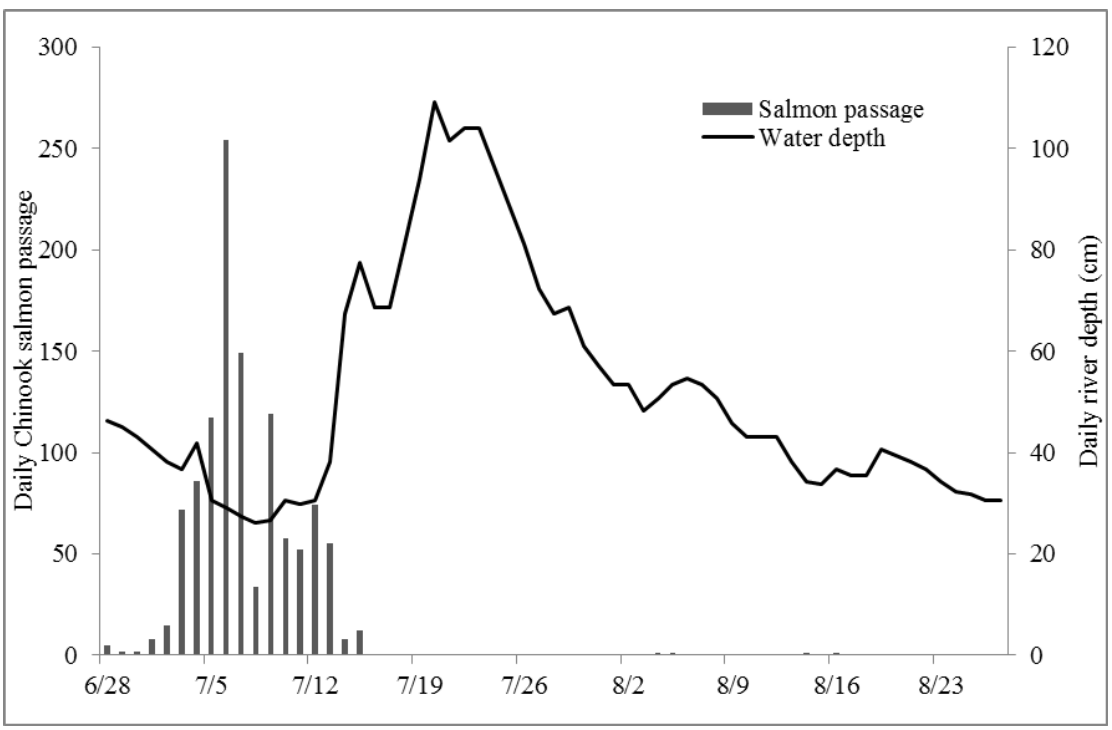

Figure 5.–Daily Chinook salmon passage and daily relative river depth (cm), 2014, Unalakleet River weir, Norton Sound.

CHINOOK SALMON RUN TIMING AND ESCAPEMENT

In 2013, from 20 June to 22 August, 667 Chinook salmon were counted at Unalakleet River weir. Daily Chinook salmon passage peaked at the weir on 11 July (107 Chinook salmon; Figure 4; Appendix A1). The central 50% of the Chinook salmon escapement occurred 7–18 July and the median passage date at the weir was 12 July for the 2013 season (Appendix A1).

In 2014, a total of 1,126 Chinook salmon were counted at Unalakleet River weir. Chinook salmon daily passage peaked on 6 July (254 Chinook salmon; Figure 5; Appendix A1). Because of difficulties associated with weir operations in 2014, timing information on 2014 Unalakleet River Chinook salmon passage could not be fully evaluated (Appendix A1). The 2014 Chinook salmon passage should be considered a minimum count.

AGE, SEX, AND LENGTH COMPOSITION

In 2013, sex composition was 52% female and the minimum sample size for age composition was not met. Females averaged 815 mm (SD = 71) in length and the mean length of male Chinook salmon was 663 mm (SD = 135); mean length of all sampled fish was 744 mm (SD = 130).

In 2014, the sampling objective was 230 Chinook salmon distributed between June 17 and July 20. A total of 184 samples were collected from June 28 to July 13 and 165 (90%) of these samples were successfully aged. Samples consisted of age-1.2 (7%), age-1.3 (68%), age-1.4 (23%), and age-1.5 (2%) fish; sex composition was 33% female. Average lengths ranged from 557 mm (SD = 48) for age-1.2 Chinook salmon to 862 mm (SD = 46) for age-1.5 Chinook salmon. Females averaged 766 mm (SD = 92) in length and the mean length of male Chinook salmon was 687 mm (SD = 78); mean length for all sampled fish was 713 mm (SD = 90; Table 3). It should be noted that, due to weir operation difficulties limiting the temporal range of collections, these samples may not be fully representative of the run if ASL composition of the run changed over the course of the season.

DISCUSSION

Despite periods of high water levels, the weir was able to deliver complete estimates of Chinook salmon escapement during the 2013 season. High water events only inhibited counting operations for a few days and the weir required minimal maintenance and repairs throughout the season. In 2014 mid-June water levels and recurring high water events throughout the summer greatly hampered counting operations, and resulted in significant periods of unmonitored passage and some minor structural damage to weir components. Therefore, the 1,126 Chinook salmon enumerated in 2014 is considered a partial estimate. More specifically, it is very likely that a significant amount of the actual mainstem weir passage was not counted in 2014. This assertion is based on proportional abundance estimates obtained from previous radiotelemetry studies (Wuttig 1999; Joy and Reed 2014) as well as the relationship between mainstem weir and tower counts observed since the weir's inception in 2010. Radiotelemetry studies showed that North River accounted for 34–55% of the overall drainagewide Chinook salmon escapement. Additionally, from 2010, 2012, and 2013, North River tower Chinook salmon passage estimates were 47–55% of the drainagewide escapement estimates. However, in 2014, the estimated 3,454

Chinook salmon enumerated at North River would be 75% of the total escapement monitored using the available weir data, which is highly unlikely.[2]

Table 2.–Chinook salmon age, sex, and mean length (METF in mm), 2014, Unalakleet River weir, Norton Sound.

Sample dates 6/28–7/13		Brood year and age class				
		2010	2009	2008	2007	
Number aged samples 165		1.2	1.3	1.4	1.5	Total
Males	Percent of samples	6.7	50.9	9.1	0.6	67.3
	Number of samples	11	84	15	1	111
	Mean length (mm)	561	693	731	884	687
	SD (Length)	48	63	60	-	76.7
Females	Percent of samples	0.6	17.0	13.9	1.2	32.7
	Number of samples	1	28	23	2	54
	Mean length (mm)	517	697	833	852	757
	SD (Length)	-	62	49	59	94.2
Total	Percent of samples	7.3	67.9	23.0	1.8	100.0
	Number of samples	12	112	38	3	165
	Mean length (mm)	557	694	792	862	710
	SD (Length)	47.9	62.4	73.2	45.5	88.9

Note: SD means standard deviation of length.

In 2013, high water conditions did not greatly hamper counting conditions. However, high water levels from 4 July to 11 July (Figure 3; Appendix A2) and a record low run made ASL sampling problematic in the fish trap near the thalweg. As a result, ASL sampling objectives were not achieved for the first time since 2010. Samples were also unevenly distributed throughout the run with 10%, 0%, 29% and 61% of the ASL samples being collected from the 1st, 2nd, 3rd and 4th quartiles, respectively. In 2014, modifications to the existing trap and the addition of the nearshore trap greatly improved sampling efficiency, even under high water conditions. The addition of the nearshore chute-trap passage facilitated sampling under conditions that would have not been possible in prior years. However, very high stream levels at the start of the 2014 season and later in July when the weir was breached resulted in early and late portions of the run not being adequately sampled.

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[2] Historical information can be found in the *Annual management report Norton Sound–Port Clarence Area and Arctic-Kotzebue* series by year (e.g., Menard et al. 2015).

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APPENDIX

Appendix A1.–Daily and cumulative Chinook salmon passage, 2013–2014, Unalakleet River weir, Norton Sound.

	2013		2014	
Date	Daily Chinook passage	Cum Chinook passage	Daily Chinook passage	Cum Chinook passage
20 Jun	0	0		
21 Jun	1	1		
22 Jun	0	1		
23 Jun	0	1		
24 Jun	1	2		
25 Jun	1	3		
26 Jun	6	9		
27 Jun	8	17		
28 Jun	2	19	5	5
29 Jun	0	19	2	7
30 Jun	0	19	2	9
1 Jul	12	31	8	17
2 Jul	29	60	15	32
3 Jul	4	64	72	104
4 Jul	3	67	86	190
5 Jul	2	69	[a] 117	307
6 Jul	21	90	[a] 254	561
7 Jul	61	151	149	710
8 Jul	43	194	34	744
9 Jul	0	194	119	863
10 Jul	12	206	[a] 58	921
11 Jul	107	313	52	973
12 Jul	42	355	74	1,047
13 Jul	39	394	55	1,102
14 Jul	21	415	8	1,110
15 Jul	27	442	12	1,122
16 Jul	18	460	0	1,122
17 Jul	20	480	0	1,122
18 Jul	14	494	0	1,122
19 Jul	15	509	0	1,122
20 Jul	54	563	0	1,122
21 Jul	49	612	0	1,122
22 Jul	16	628	0	1,122
23 Jul	4	632	0	1,122
24 Jul	2	634	0	1,122
25 Jul	7	641	0	1,122
26 Jul	7	648	0	1,122
27 Jul	1	649	0	1,122
28 Jul	2	651	0	1,122
29 Jul	1	652	0	1,122
30 Jul	2	654	0	1,122
31 Jul	1	655	0	1,122

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	2013		2014	
Date	Daily Chinook passage	Cum Chinook passage	Daily Chinook passage	Cum Chinook passage
1 Aug	2	657	0	1,122
2 Aug	0	657	0	1,122
3 Aug	0	657	0	1,122
4 Aug	0	657	1	1,123
5 Aug	0	657	1	1,124
6 Aug	1	658	0	1,124
7 Aug	0	658	0	1,124
8 Aug	1	659	0	1,124
9 Aug	0	659	0	1,124
10 Aug	1	660	0	1,124
11 Aug	0	660	0	1,124
12 Aug	0	660	0	1,124
13 Aug	1	661	0	1,124
14 Aug	0	661	1	1,125
15 Aug	1	662	0	1,125
16 Aug	0	662	1	1,126
17 Aug	1	663	0	1,126
18 Aug	1	664	0	1,126
19 Aug	0	664	0	1,126
20 Aug	0	664	0	1,126
21 Aug	1	665	0	1,126
22 Aug	2	667	0	1,126
23 Aug			0	1,126
24 Aug			0	1,126
25 Aug			0	1,126
26 Aug			0	1,126
27 Aug			0	1,126

Note: Grey shaded box indicates median passage dates, and lighter enclosed box delineates the central 50% of run. Median passage in 2014 could not be determined because the Chinook salmon run was not fully monitored.

[a] Partial day count.

Appendix A2.–Relative stream stage depth (cm) as indicated by stream gauge measurements, 2013–2014, Unalakleet River weir, Norton Sound.

Date	2013	2014
20 Jun	14.3	
21 Jun	12.5	
22 Jun	10.4	
23 Jun	7.6	
24 Jun	5.6	
25 Jun	3.4	
26 Jun	2.1	
27 Jun	2.4	
28 Jun	2.7	46.4
29 Jun	1.1	45.1
30 Jun	0.3	43.2
1 Jul	10.4	40.6
2 Jul	33.2	38.1
3 Jul	37.5	36.8
4 Jul	47.5	41.9
5 Jul	85.0	30.5
6 Jul	79.2	29.2
7 Jul	71.0	27.3
8 Jul	79.6	26.0
9 Jul	ND	26.7
10 Jul	97.5	30.5
11 Jul	78.0	29.8
12 Jul	61.9	30.5
13 Jul	50.0	38.1
14 Jul	41.1	67.3
15 Jul	36.9	77.5
16 Jul	43.0	68.6
17 Jul	44.2	68.6
18 Jul	39.6	81.3
19 Jul	44.2	94.0
20 Jul	57.6	109.2
21 Jul	62.2	101.6
22 Jul	54.9	104.1
23 Jul	48.2	104.1
24 Jul	43.0	96.5
25 Jul	38.1	88.9
26 Jul	34.7	81.3
27 Jul	30.5	72.4
28 Jul	28.0	67.3
29 Jul	25.9	68.6
30 Jul	22.9	61.0
31 Jul	20.1	57.2
1 Aug	18.0	53.3
2 Aug	17.1	53.3

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Appendix A2.–Page 2 of 2.

Date	2013	2014
3 Aug	17.4	48.3
4 Aug	21.6	50.8
5 Aug	ND	53.3
6 Aug	21.3	54.6
7 Aug	19.8	53.3
8 Aug	18.9	50.8
9 Aug	20.1	45.7
10 Aug	23.2	43.2
11 Aug	26.2	43.2
12 Aug	27.7	43.2
13 Aug	27.7	38.1
14 Aug	27.4	34.3
15 Aug	29.0	33.7
16 Aug	29.3	36.8
17 Aug	27.3	35.6
18 Aug	25.3	35.6
19 Aug	24.4	40.6
20 Aug	26.2	39.4
21 Aug	25.0	38.1
22 Aug	24.7	36.8
23 Aug		34.3
24 Aug		32.4
25 Aug		31.8
26 Aug		30.5
27 Aug		30.5